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8690
MILLIVOLT POTENTIOMETER

LEEDS NORTHRUP
PHILADELPHIA 44, PA.

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1. INTRODUCTION

A. General Description

This instrument, a general view of which is shown in Fig. 1, is a single range, two-dial portable potentiometer. It is primarily for general temperature measurements, by means of thermocouples, within the range of -11.0 to +101.0 millivolts without reversing the input connections. It also can be used for checking thermocouple pyrometers, in laboratory and plant, and as a calibrated source of voltage (emf output).

The basic instrument consists of a millivolt selector switch, a slidewire, and a switch to select the function to be performed. Also included are, a galvanometer, a standard cell, and a 1-1/2 volt battery.

The millivolt value determined by the position of the selector switch, appears at the window adjacent to the operating knob while the value determined by the position of the slidewire, appears at the center window. The sum of these two readings is the value of voltage set on the potentiometer. The 0 to -11 millivolts range is obtained by turning the millivolts selector switch to the minus (-) position. In this case, all measurements are made by adjusting only the slidewire and the values (negative) of voltage appear at the slidewire scale window.

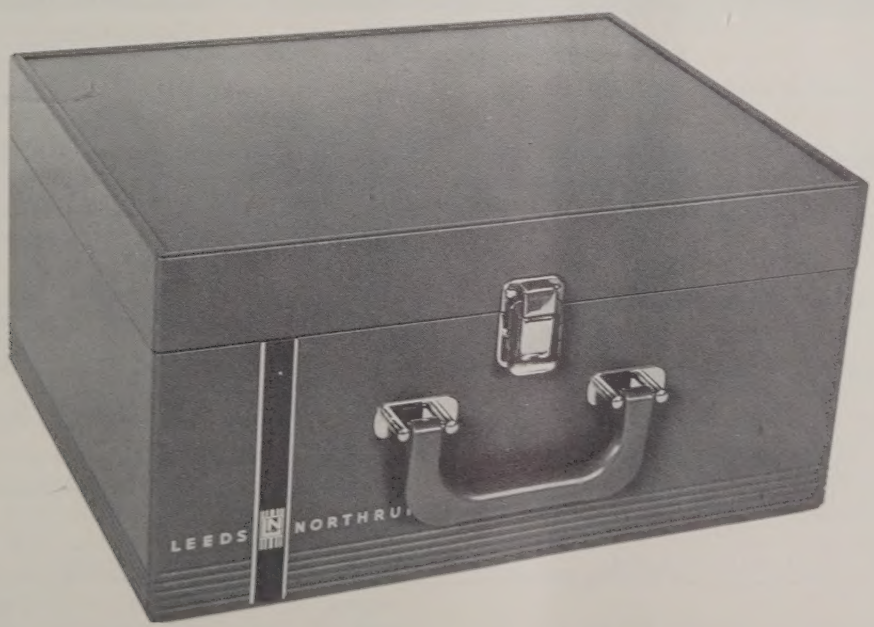


Fig. 1—8690 Potentiometer, exterior.

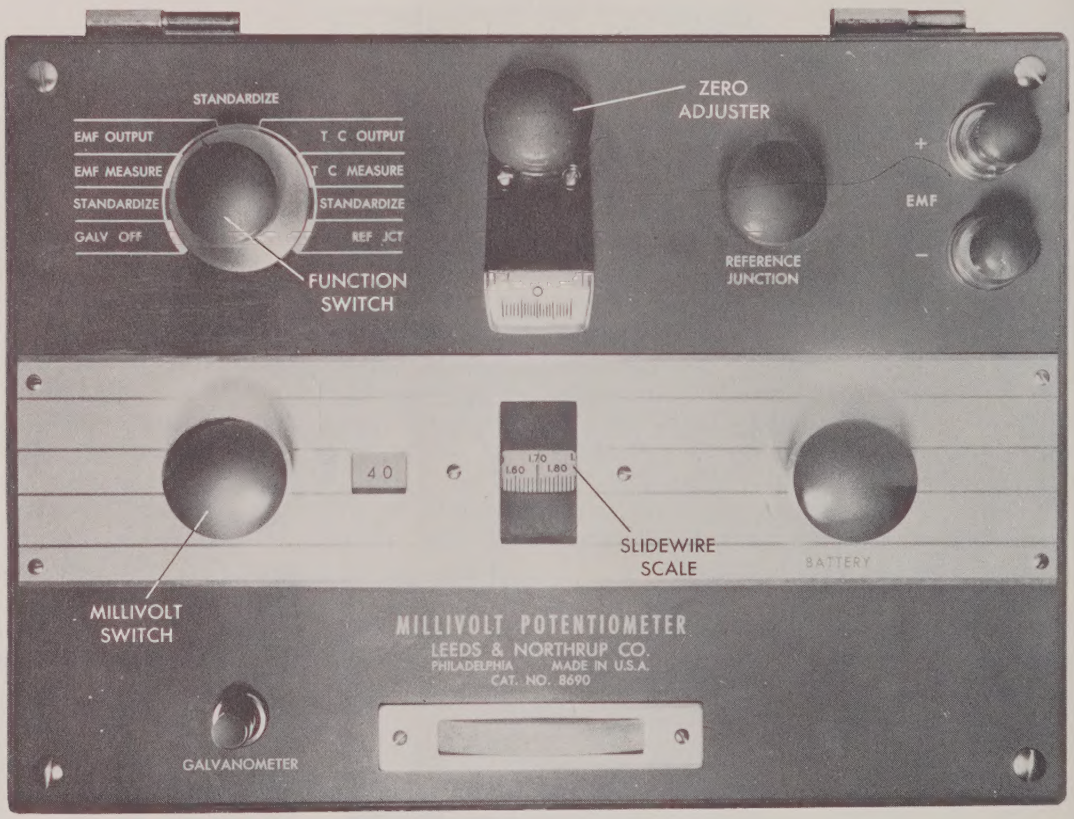


Fig. 2—8690 Potentiometer, top view with lid removed.

B. Specifications

RANGE	−11.0 mv to +101.0 mv
LIMITS OF ERROR	±(0.05% of reading + 20 μv) without ref. jct. comp. ±(0.05% of reading + 40 μv) with ref. jct. comp.
MEASURING DIALS	Millivolt dial, 9 x 10 millivolts and a minus (−) position. Slidewire, 0-11 millivolts, smallest division 0.02 millivolt.
REF. JCT. COMP. RANGE	0-5 millivolts (uncalibrated), adjustable to ±5 microvolts.
STD. CELL ADJ. RANGE	1.017 to 1.0200 volts (uncalibrated).

TABLE I—FUNCTION SWITCH, DESCRIPTION OF POSITIONS

SWITCH POSITION	FUNCTION
GALV OFF	Galv. disconnected. No measurement can be made.
STANDARDIZE	Standardize potentiometer current
EMF MEASURE	Measure uncompensated voltage
EMF OUTPUT	Source of uncompensated voltage
TC MEASURE	Measure compensated thermocouple voltage
TC OUTPUT	Source of compensated voltage
REF JCT	REFERENCE JUNCTION compensator can be adjusted

2. DESCRIPTION OF MAJOR COMPONENTS

A. Function Switch

This switch is operated by the knob indicated in Fig. 2. The functions that can be performed for the various positions of the switch are shown in Table I.

This switch should be in the GALV OFF position, when storing or transporting the instrument, to protect the galvanometer.

B. Battery Rheostat

The BATTERY rheostat (3 turn) is used with the 1-1/2 volt battery, Fig. 3, to standardize the current in the potentiometer circuit.

C. Galvanometer Key

The GALVANOMETER key is normally open so as to open the circuit to the galvanometer while making connections to the potentiometer and while making preliminary adjustments for a measurement. This prevents the galvanometer from receiving hard bumps which might be caused by a large unbalance in the potentiometer circuit while making preliminary adjustments.

This key must be closed to determine circuit balance. It is normally open and is closed when depressed. It will lock closed if it is turned in a clockwise direction as it is depressed.

D. Reference Junction Compensator

This ten-turn slidewire is used to adjust the reference junction when using the potentiometer for measuring a compensated thermocouple voltage or as the source of a calibrated compensated voltage.

E. Standard Cell Voltage Divider

This voltage divider, see Fig. 4, is used to compensate for any slight change in the voltage of the standard cell.

F. Potentiometer Balancing Switch and Slidewire

This millivolt switch and slidewire (knurled wheel), Fig. 2, are used to obtain a circuit balance when measuring an unknown voltage or to set the value of the calibrated voltage when using the instrument as a voltage source.

Table II gives pertinent data on these components.

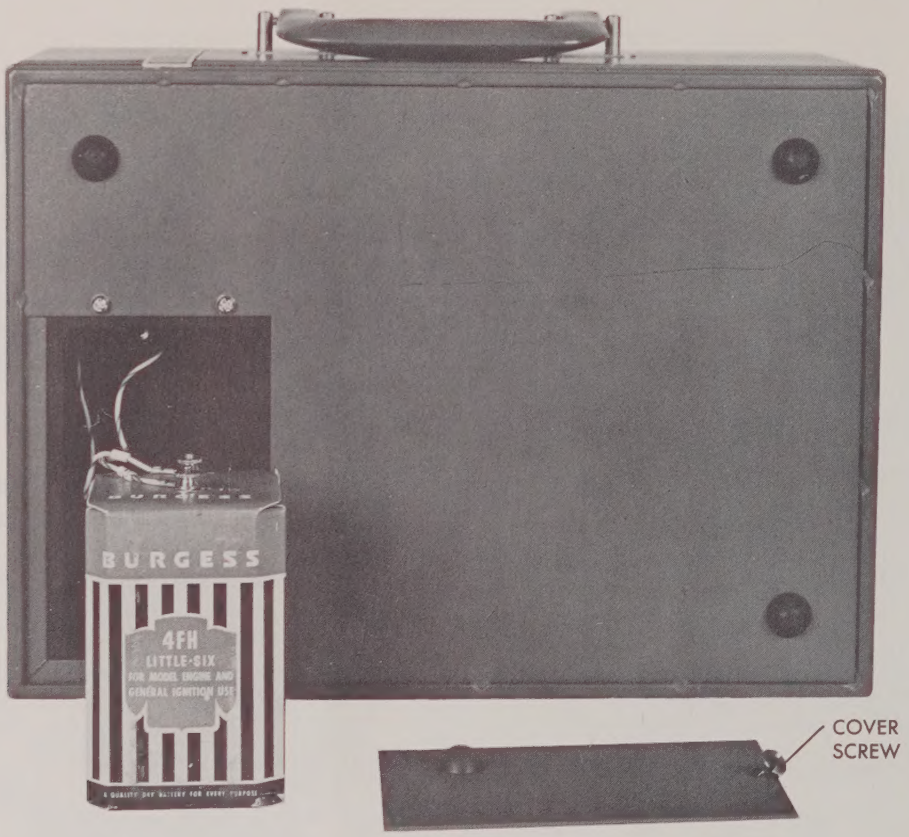


Fig. 3—8690 Potentiometer, bottom view with cover removed to show battery.

Each numbered division (step) on the scale of the millivolts switch is equal to a change of 10 millivolts. Each numbered division on the scale of the slidewire is equal to a change of 0.1 millivolts. However, its scale is divided so that the smallest division is equal to 0.02 millivolt.

The setting of the millivolt switch appears at the window adjacent to the operating knob of this switch while

TABLE II—MILLIVOLTS SWITCH AND SLIDEWIRE, RANGES

	POSITIONS	SCALE MARKINGS	RANGE (Millivolts) *	RANGE (Millivolts) △
MILLIVOLT SWITCH	(11) 0 1-10	— 00-90	— ——	—— 0-90
SLIDEWIRE (Knurled Wheel)	2000 (approx.)	0-11	0-11	0-11
		TOTAL RANGE	(—) 11-0	0-101

*—This range used for negative voltages.
△—This range used for positive voltages .

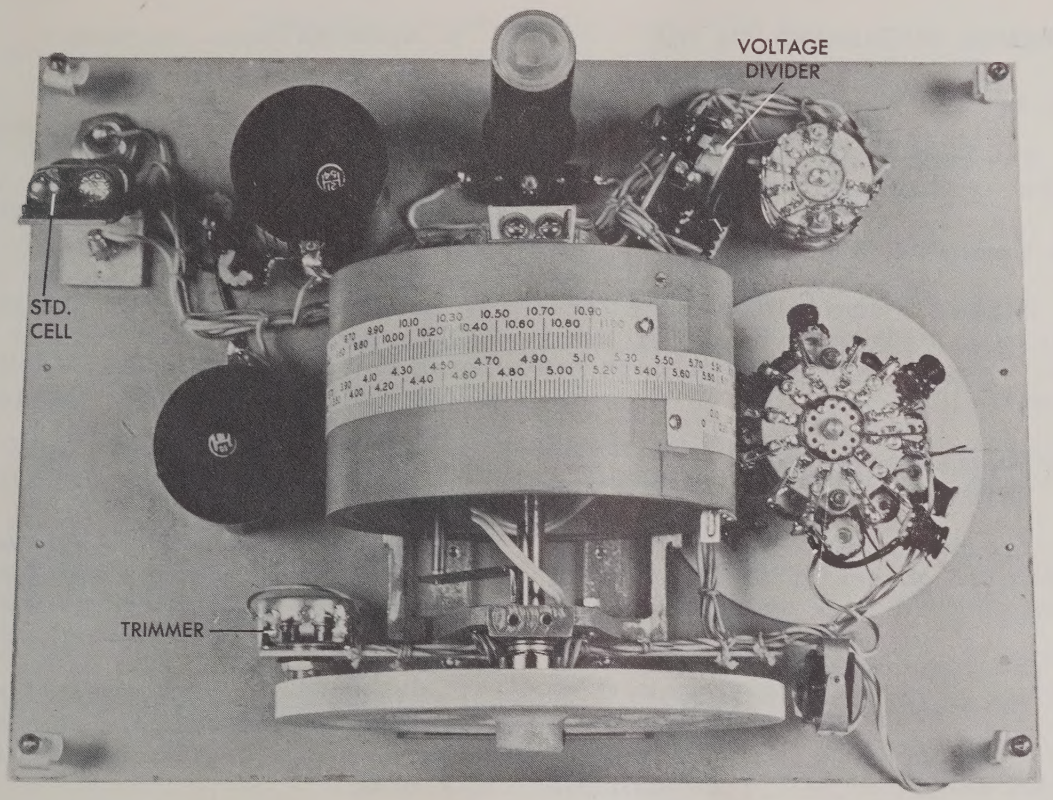


Fig. 4—8690 Potentiometer, detailed view of under side of instrument panel.

the setting of the slidewire appears at the center window.

G. Galvanometer

The galvanometer is a complete pointer type unit with the following nominal characteristics.

Sensitivity.	±0.6 μa/mm (±75 μv/mm)
Coil Resistance	.25 ohms
CDRX.	100 ohms
Period	.3 seconds

H. Standard Cell

The standard cell is mounted on a bracket as shown in Fig. 4. It is an unsaturated cell and should be used where the ambient temperature remains between 0 C and 50 C (32 F and 122 F).

The useful life of the cell, with periodic calibration, should be approximately five to seven years.

I. Battery

A single 1.5 volt battery is used to furnish current to the potentiometer circuit and is mounted in a compartment in the bottom of the instrument case as shown in Fig. 3. The battery is made available by removing the screw from the edge of the cover plate and removing this cover as in Fig. 3.

3. PREPARE INSTRUMENT FOR USE

A. Battery

The battery should need no attention until it needs to be replaced.

B. Standard Cell

This cell should need no attention, except for periodic calibration, until a check shows that it must be replaced.

C. Adjust Mechanical Zero of Galvanometer

The mechanical zero of the galvanometer should be checked and, if necessary, adjusted as follows.

See that the GALVANOMETER key is open (in the up position).

Turn the function switch to one of the STANDARDIZE positions and observe the balance point of the galvanometer. If it does not balance at zero, turn the zero adjuster, Fig. 2, until this balance is obtained.

D. Voltage Connections

If a voltage source is to be measured, connect it to the EMF terminals.

If the potentiometer is to be used as a source of calibrated voltage, connect the device to be supplied by this voltage to the EMF terminals.

4. OPERATION

A. Check Mechanical Zero of Galvanometer

Make this check as indicated in Section 3C.

B. Standardize Potentiometer Circuit Current

Turn the function switch to one of the STANDARDIZE positions.

Depress the GALVANOMETER key and note the galvanometer pointer for any deflection. If the pointer does not balance at zero, adjust the BATTERY rheostat until the pointer remains at zero when the GALVANOMETER key is depressed or released.

C. Adjust Reference Junction Compensator

This adjustment is necessary only under two conditions, (1) when measuring the voltages of a thermocouple when the reference junction temperature is other than 32 F (0 C), (2) when using the instrument to supply a similar voltage when the reference junction temperature is other than 32 F (0 C).

If, for either of the two conditions mentioned above, the reference junction temperature is exactly 32 F (0 C), as would be the case when using an ice bath, the reference junction compensator in the 8690 Potentiometer should be switched out of the circuit, to obtain maximum accuracy. This is accomplished by placing the function switch in either the EMF MEASURE or EMF OUTPUT position and making an uncompensated measurement as indicated in Section 4D or 4E.

When using the reference junction compensator in the 8690 Potentiometer, adjust it as follows:

- Set the millivolt switch at 00 and turn the knurled wheel so that the reading at the slidewire window equals the millivolt equivalent of the reference junction temperature. Refer to Conversion Tables for this value.

TABLE III—MEASURE VOLTAGE, BASIC STEPS

TYPE OF VOLTAGE MEASUREMENT	RANGE (Millivolts)	POSITION OF FUNCTION SWITCH	ADJUST REF. JCT. COMP.	MAKE READING PER
UNCOMPENSATED	0-101	EMF MEASURE	No	Section 4D(2)
UNCOMPENSATED	(—) 11-0	EMF MEASURE	No	*Section 4D(2)
TC COMPENSATED	0-101	TC MEASURE	Yes	Section 4D(2)
TC COMPENSATED	(—) 11-0	TC MEASURE	Yes	*Section 4D(2)

*Except, turn the millivolts switch to the minus (—) position and use only the slidewire (knurled wheel) to obtain a balance.

- Turn the function switch to the REF JCT position.

- Depress the GALVANOMETER key and adjust the REFERENCE JUNCTION compensator until a galvanometer balance is obtained.

- Turn the function switch to either TC MEASURE or TC OUTPUT, as required.

D. Measure Voltage

(1) Preliminary Adjustments

Be sure that all preliminary checks and adjustments have been made. Then, use Table III and operate the various components indicated for the voltage range which covers the voltage to be measured.

(2) Make a Reading

- Turn the millivolt switch to 00 and the slidewire to 0 on their respective scales.

- Depress the GALVANOMETER key and note the direction of deflection of the galvanometer pointer.

- Turn the millivolt switch clockwise, one position at a time, depressing the GALVANOMETER key momentarily at each position, until the direction of deflection of the galvanometer reverses.

- Turn the millivolt switch back one position.

- Rotate the knurled wheel slowly to the left, to adjust the slidewire, using the GALVANOMETER key to check for a galvanometer deflection, until the galvanometer balances at zero.

- Read the values at both windows. The sum of these two readings is the value of millivolts being measured. This may be either a positive or a negative value, depending upon the position of the millivolts switch.

E. Supply Standard Voltage

(1) Preliminary Adjustments

CAUTION: This instrument can be used as a voltage source but is not designed to supply current. Therefore, it should be used only in null circuits.

Be sure that all preliminary checks and adjustments have been made.

Close the GALVANOMETER key and lock it in this position to

TABLE IV—SUPPLY VOLTAGE, BASIC STEPS

TYPE OF VOLTAGE TO BE SUPPLIED	RANGE (Millivolts)	POSITION OF FUNCTION SWITCH	ADJUST REF. JCT. COMP.	OBTAIN VOLTAGE PER
UNCOMPENSATED	0-101	EMF OUTPUT	No	Section 4E(2)
UNCOMPENSATED	(—) 11-0	EMF OUTPUT	No	*Section 4E(2)
TC COMPENSATED	0-101	TC OUTPUT	Yes	Section 4E(2)
TC COMPENSATED	(—) 11-0	TC OUTPUT	Yes	*Section 4E(2)

*Except, turn the millivolts switch to the minus (—) position and use only the slidewire (knurled wheel) to obtain a balance.

complete the circuit.

Use Table IV and operate the various components indicated for the voltage range which covers the voltage to be supplied.

(2) Obtain Voltage

Rotate the millivolt switch and the slidewire (knurled wheel) until the sum of the setting equals the desired voltage.

5. MAINTENANCE

A. To Remove Instrument Panel

Turn each mounting screw (one in each corner of the panel) two complete turns counterclockwise to release the clamping nut from the ledge inside the case. The mounting screws remain in place on the panel. Lift the panel from the case.

B. To Replace Instrument Panel

Turn the clamping nut, on each mounting screw, so that it will clear the ledge inside the case when the panel is fitted into place on the case. After the panel is positioned on the case, turn each mounting screw counterclockwise until a click is heard and then turn each screw clockwise until it is tight.

C. Battery

When the BATTERY rheostat reaches the limit of its adjustment because of a depleted battery, the 1-1/2 volt battery, Fig. 3, should be replaced.

To replace this battery, remove the screw, Fig. 3, and lift the cover off the compartment.

D. Galvanometer

To replace the complete galvanometer unit, remove the two screws from the top of the galvanometer housing and lift the unit from the instrument panel.

E. Standard Cell

(1) Replace

This cell should give satisfactroy service for several years. However, if it is ever necessary to replace it, remove the instrument panel from the case, and note the connections to the cell. Then disconnect and remove it from the panel.

(2) Adjust for Standard Cell Voltage

The limit of error (accuracy) of the potentiometer includes the

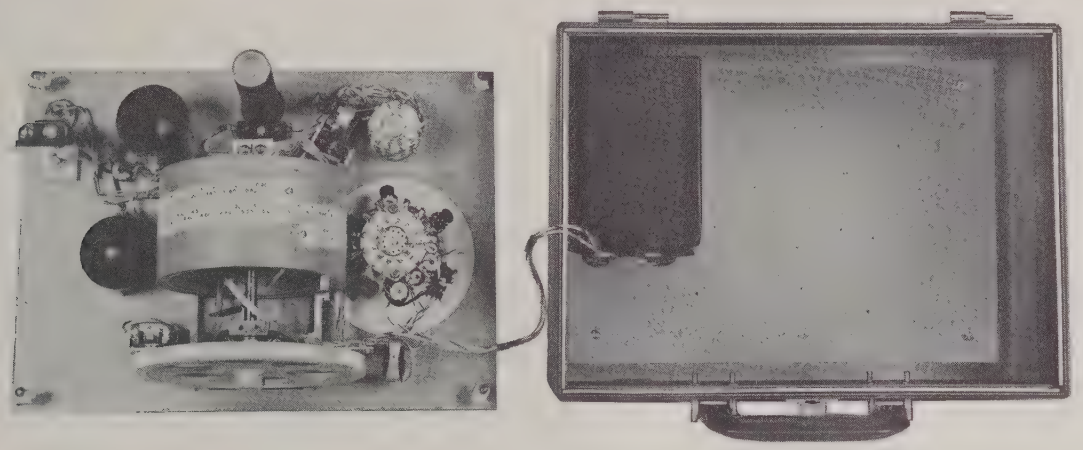


Fig. 5—8690 Potentiometer, view showing under side of instrument panel and inside of case.

accuracy of the standard cell. Thus, a change in voltage of this cell will affect the accuracy of the readings. Therefore, it is recommended that the voltage of the standard cell be checked approximately once a year, using the following procedure.

- Apply 100 millivolts (±0.02%), from a precision potentiometer, to the EMF terminals of the instrument.

- Set the millivolt switch and the knurled wheel to obtain the value of the voltage, connected in the preceding paragraph, at the windows.

- Turn the function switch to EMF MEASURE.

- Adjust the BATTERY rheostat, depressing the GALVANOMETER key at intervals, to obtain a galvanometer balance.

- Turn the function switch to one of the STANDARDIZE positions.

- Lock the GALVANOMETER key closed. If the galvanometer balances at zero, no adjustment of the voltage divider is necessary.

- If the galvanometer does not balance at zero, remove the instrument panel from the case to make the voltage divider available. Stand the panel on the lower edge, as viewed in Fig. 4, with the face of the panel approximately vertical. Loosen the locknut on the slotted end of the shaft of the voltage divider. Insert a screwdriver in the slot and adjust the voltage divider until a galvanometer balance is obtained. Then tighten the locknut.

- Release the GALVANOMETER key and replace the panel in the case.

F. Cleaning

(1) Measuring Circuit Slidewire

This slidewire may require occasional cleaning, over extended periods of time, depending upon the conditions under which the instrument is used. Remove the instrument panel from the case. Rub a clean cloth, moistened with Cramolin (L&N Part No. 090019, 2 oz. bottle of the solution), over the contact surface of the slidewire. Allow the Cramolin to remain for at least 30 seconds and then

remove any excess with a clean section of cloth. Do not apply any lubricant to the slidewire and never use an abrasive material on it as this would destroy the uniformity of the slidewire.

(2) General

The finish on this instrument is a paint which has greater resistance to chipping and scratching than a baked enamel finish. If necessary, the top panel may be cleaned with a soft cloth dampened with a solution of water and a small amount of mild detergent.

The windows and instrument panel may be cleaned in the same manner.

The insulators of the EMF terminals are a plastic which is affected by some chemical solvents. Therefore, chemical solvents should not be used.

6. REPLACEMENT PARTS

Description	L&N® Part No.
Battery, 1-1/2 volt (Burgess, 4FH, Little Six)	Std. 2233-1
Standard Cell	130007
Galvanometer, complete unit	062112
Head, for EMF terminals	002199
Screw Assembly, panel mounting	- - -
Screw	4-4-1-24
Spring, upper	28-1-3-10
Spring, lower	28-1-3-9
Clamp nut	72-4-1-1
Retaining Ring	27-3-3-12
Window, lucite strip	066126
Key, GALVANOMETER	PI-123-L

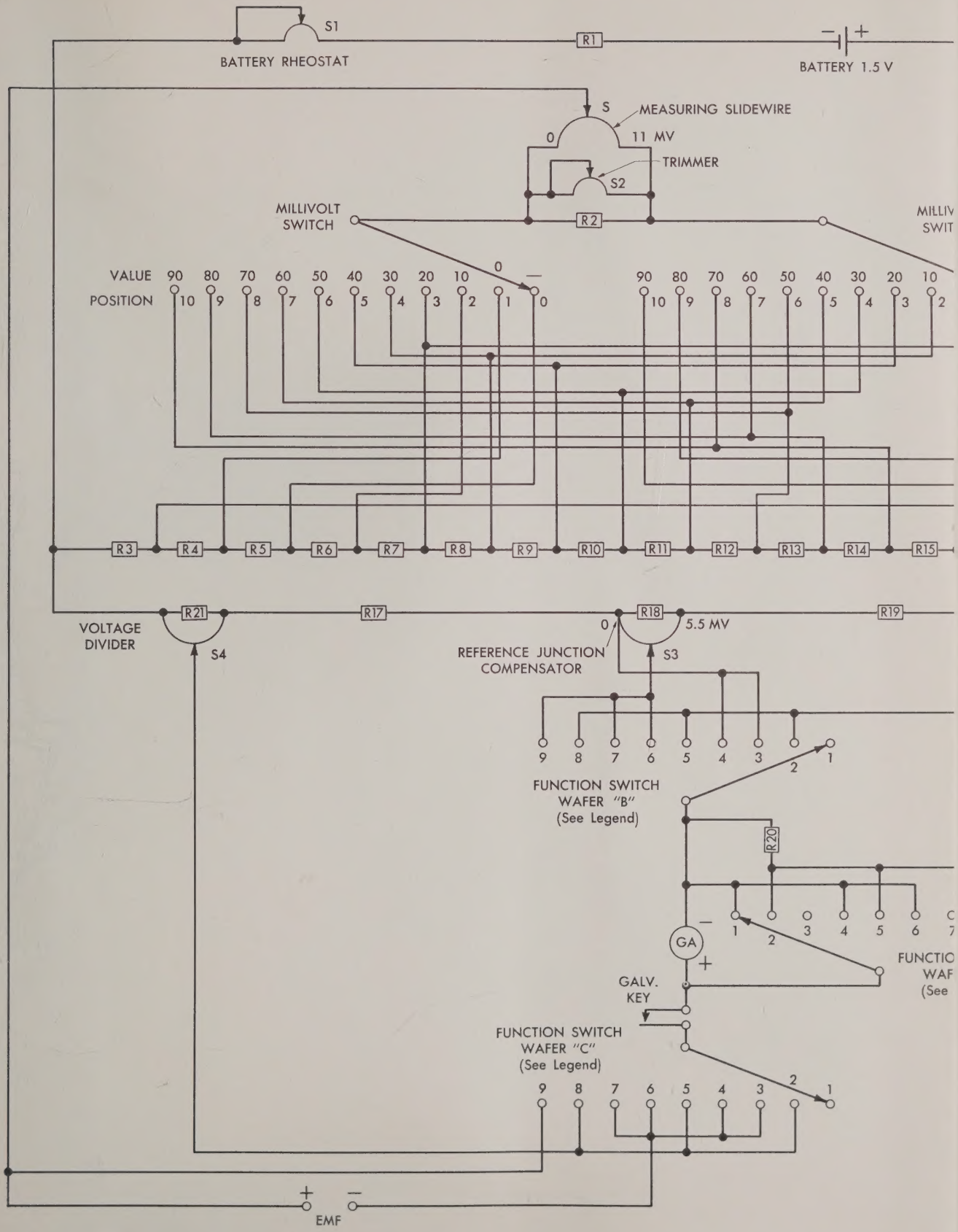
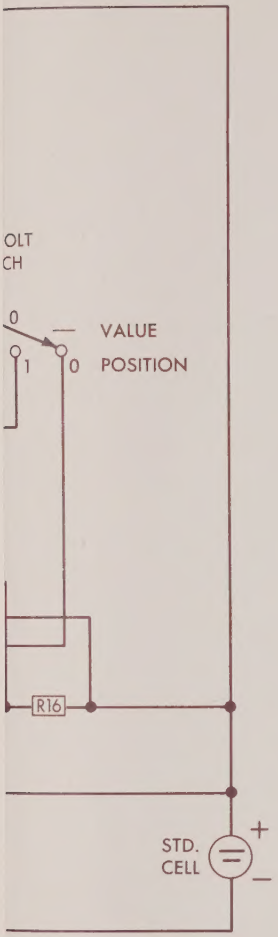


Fig. 6—8690 Potentiometer, wiring con

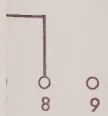


RESISTORS

Symbol	Value	Symbol	Value
R1	20.0 Ω	R12	5.000Ω
R2	14.651Ω	R13	
R3	454.640Ω	R14	
R4	5.500Ω	R15	
R5	4.500Ω	R16	5.000Ω
R6	0.500Ω	R17	458.195Ω
R7	5.000Ω	R18	2.828Ω
R8		R19	47.75 Ω
R9		R20	120.0 Ω
R10		R21	1.500Ω
R11	5.000Ω		

MISCELLANEOUS

Symbol	Value	Description	L&N Part No.
S	——	Measuring slidewire	012384
S1	140Ω	BATTERY rheostat	013204
S2	4000Ω	Trimmer potentiometer	013203
S3	100Ω	REFERENCE JUNCTION rheostat	013202
S4	4000Ω	SC calibration voltage divider	013203



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FUNCTION SWITCH LEGEND

1—GALV OFF
2—STANDARDIZE
3—EMF MEASURE
4—EMF OUTPUT
5—STANDARDIZE
6—TC OUTPUT
7—TC MEASURE
8—STANDARDIZE
9—REF JCT

nections.

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